Metallic erosion shields are used to protect composite materials. We have developed innovative new concepts which demonstrate composite materials can provide this, but to fully extract the mass saving benefit, we must develop solutions which make them more resistant to damage.

What is the problem?
- Decarbonising aviation is a global challenge. The UK Aerospace sector must act now to be a part of this radical change – this is essential to not only protect the environment, but also to protect the UK aerospace industry.

What are the solutions?
- Net zero concepts for civilian aircraft require more mass efficient structures. Composite materials can provide this.
- To capitalise on the net zero opportunity the demonstrated concepts must be applied at a higher TRL level with industry partners to realise our end goal of net zero aviation.

Profiling concept for leading edge protection

- Feature: Metallic erosion shields are used to protect composite leading edges on blades and wings
- Vulnerability: The step change in stiffness at the edge of the erosion shield can accelerate failure in the composite part
- Concept: Larger load transfer region better distributes stress
- Progressive stiffness transition across joint

Bio-inspired embedded stiffener for improved damage tolerance

- Feature: Composite stiffened panels are composed of ‘skins’ with ‘stiffeners’ bonded to the surface
- They are used to provide structural stiffness in a mass efficient manner
- Vulnerability: Stiffeners are vulnerable to separation failure
- Concept: Tree branches are embedded to the centre of the trunk creating a structure which is very damage tolerant
- I designed a composite stiffened panel with the stiffener attachment embedded to the centre of the skin inspired by this biological structure

3D reinforcement for delamination resistance

- Feature: Composites are usually manufactured as ‘laminates’ – many layers of fibres pressed together with each layer comprising fibres of a single orientation
- Vulnerability: These layers can separate (delamination), resulting in a rapid loss of stiffness and structural integrity
- Concept: Using tape-by-tape manufacturing, split piles into segments of alternating tapes

Conclusions & future direction

- We have developed innovative new concepts which demonstrate composite materials can be used to create damage resistant structures and by extension the aircraft of the future
- To capitalise on the net zero opportunity the demonstrated concepts must be applied at a higher TRL level with industry partners to realise our end goal of net zero aviation